RAIN, HAIL OR SNOW: WHICH WILL IT BE

A radio talk by Edward H. Bowie, Principal Meteorologist, in charge, San Francisco Forecast District (States of California, Nevada, Oregon, Washington and Idaho), Weather Bureau, United States Department of Agriculture, delivered during the Western Farm and Home Hour Thursday, February 25, 1932, through Station KGO and eight other stations associated with the NBC-KGO network, Pacific Division, National Broadcasting Company.

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The air at all times contains more or less invisible water vapor, the stuff of which clouds are made. At no time has air in its natural condition been observed to be entirely free of this cloud-making material. In some instances, however, the amount observed has been so small that the percentage of possible water vapor present in the air has been recorded as less than one per cent, or a "trace". A trace is an amount too small to be recorded by instruments commonly used for measuring the humidity of the air.

The capacity of the air, or rather space, for this material of which clouds are made, is determined by its temperature and nothing else. This capacity for water vapor increases with temperature. And it follows that as the temperature decreases, the capacity of the air -- or space -- for water vapor is correspondingly lessened. From which it follows that clouds will form if the temperature of the air with which the water vapor is mixed is lowered sufficiently, provided there are motes or dust particles to act as nuclei on which water vapor may condense. If the temperature is high and the amount of water vapor present is small a large fall in temperature must be accomplished before any of the water vapor present is condensed on the nuclei to form cloud particles. When, however, there is much water vapor in the air, a relatively small drop in temperature may result in the fogging of the air to considerable depths, that is, the formation of a cloud layer of thousands of feet in thickness.

The most commonly observed fogging of the air results from cooling of the air near the earth's surface. This we call ground fog. It most often occurs during the night or early morning when the earth's surface is at its lowest temperature, and the air immediately adjacent to it has been cooled by loss of heat by radiation and conduction. Free air cooling likewise results in the formation of cloud or fog. It has been said that there is no appreciable difference between the ground fog and the stratus cloud. "The cloud is a fog high up and fog is a cloud low down," said a small scholar to his teacher in response to the question as to what is the difference between a cloud and a fog. Of course, this is not literally true of all clouds, but it is true in respect to the cloud that is known as Stratus.

The findings of meteorologists and physicists are to the effect that with falling temperature, if continued to and below the temperature of saturation, the air must give up its invisible water vapor to form cloud provided there are present nuclei on which the water vapor can be condensed. If the nuclei are not present a condition known as supersaturation will result and the change of the water vapor to cloud particles is greatly retarded despite the fall in temperature.

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It follows then that the physical processes that produce rain, hail and snow must be different in some fundamental particulars. Of these the most important is the temperature of the air at the time condensation sets in and during the time condensation continues. It may be accepted as a fact that when condensation sets in and continues with the temperature above 32 degrees Fahrenheit, the resulting precipitation will be in the form of rain. It does not follow, however, that all precipitation that reaches the earth's surface as rain was in a liquid form at the altitude where condensation took place. Rather it appears probable that in many instances of rain, the condensed particles were in the form of snow or hail and melted in falling through warmer strata of air to the earth's surface.

Accepting it to be a fact that when condensation occurs with temperatures above 32 degrees the precipitation formed is a liquid, it follows that when the condensation takes place in a medium that has a temperature below 32 degrees, the condensed particles must form solids, i.e., of the nature of ice or snow crystals. This is accepted generally to be true. Hence, the question of whether precipitation will be rain, hail or snow is dependent first on temperature, i.e., whether it is above or below freezing. With temperatures above freezing, there can be no doubt that all condensation is of a liquid nature. Then if below freezing, the condensation must form snow or hail. But one inquires why in one instance it is hail and in another snow? The answer is that snow is probably associated with conditions rather more like those accompanying the formation of rain, except that the question of temperature, whether below or above freezing, is the determinant. In the matter of hail, something else is involved. If a hailstone is carefully examined, it will be found to consist of a nucleus of snow around which there are several concentric and alternating layers of ice and snow. Moreover, true hail occurs rarely except in connection with the so-called "heap" clouds that are commonly associated with thunderstorms or conditions that are likely to give rise to thunderstorms. We know that in thunderstorms there are rapidly ascending and descending currents, and from this the explanation is set forth that a hailstone gets its nucleus of snow in a rising air current where condensation sets in at an altitude where the temperature is at or below freezing point. This nucleus is carried upward and, on passing from the region of ascending air, falls to an altitude where the temperature is above freezing. Here there is an accretion of water by condensation, or some of the outer snow is melted and becomes water. The initial hailstone is brought again into the rapidly rising air current, carried upward, the water changed to a coating of ice, the ice later acquiring a coating of snow. This process is repeated again and again until the hailstone by reason of its weight falls to the earth. In some instances, several true hailstones are frozen together and the combined mass falls to the earth's surface as a prodigious hailstone of the weight of a pound or more. True hail is rarely observed in the cold months; it is distinctly a hot weather phenomenon, and one almost invariably associated with conditions that give rise to thunderstorms. In the winter there are frequently observed ice pellets, or frozen raindrops. In such instances, the raindrop formed in a stratum of air having a temperature above freezing and was carried upward and frozen solid and subsequently fell to the earth's surface, or else fell through a stratum of air having a temperature below freezing which caused the raindrop to freeze. Frozen raindrops are commonly known as sleet, although the English define sleet as a mixture of snow and rain. In the mountains, and not infrequently in the lowlands and plains, there occur what are known as ice storms. The

explanation is that condensation is active in a stratum of air of a temperature above 32 degrees. The raindrops fall through a lower stratum of colder air and on coming in contact with objects such as trees, wires, etc., having a temperature below 32 degrees, the raindrops adhere to them and are quickly turned to ice.